Functional Safety Information

PCA9306-Q1
Functional Safety FIT Rate, FMD and Pin FMA

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1 Overview

This document contains information for PCA9306-Q1 (VSSOP package) to aid in a functional safety system design. Information provided are:

- Functional Safety Failure In Time (FIT) rates of the semiconductor component estimated by the application of industry reliability standards
- Component failure modes and their distribution (FMD) based on the primary function of the device
- Pin failure mode analysis (Pin FMA)

Figure 1-1 shows the device functional block diagram for reference.

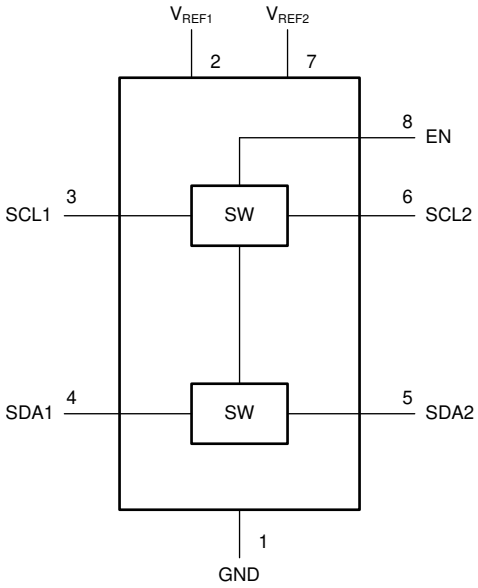

Figure 1-1. Functional Block Diagram

PCA9306-Q1 was developed using a quality-managed development process, but was not developed in accordance with the IEC 61508 or ISO 26262 standards.

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2 Functional Safety Failure In Time (FIT) Rates

This section provides Functional Safety Failure In Time (FIT) rates for PCA9306-Q1 based on two different industry-wide used reliability standards:

- Table 2-1 provides FIT rates based on IEC TR 62380 / ISO 26262 part 11
- Table 2-2 provides FIT rates based on the Siemens Norm SN 29500-2

Table 2-1. Component Failure Rates per IEC TR 62380 / ISO 26262 Part 11

FIT IEC TR 62380 / ISO 26262	FIT (Failures Per 10^9 Hours)
Total Component FIT Rate	5
Die FIT Rate	2
Package FIT Rate	3

The failure rate and mission profile information in Table 2-1 comes from the Reliability data handbook IEC TR 62380 / ISO 26262 part 11:

- Mission Profile: Motor Control from Table 11
- Power dissipation: 20 mW
- Climate type: World-wide Table 8
- Package factor (lambda 3): Table 17b
- Substrate Material: FR4
- EOS FIT rate assumed: 0 FIT

Table 2-2. Component Failure Rates per Siemens Norm SN 29500-2

Table	Category	Reference FIT Rate	Reference Virtual T_J
5	CMOS, BICMOS ASICs Analog & Mixed =<50V supply	20 FIT	55°C

The Reference FIT Rate and Reference Virtual T_J (junction temperature) in Table 2-2 come from the Siemens Norm SN 29500-2 tables 1 through 5. Failure rates under operating conditions are calculated from the reference failure rate and virtual junction temperature using conversion information in SN 29500-2 section 4.

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3 Failure Mode Distribution (FMD)

The failure mode distribution estimation for PCA9306-Q1 in Table 3-1 comes from the combination of common failure modes listed in standards such as IEC 61508 and ISO 26262, the ratio of sub-circuit function size and complexity and from best engineering judgment.

The failure modes listed in this section reflect random failure events and do not include failures due to misuse or overstress.

Table 3-1. Die Failure Modes and Distribution

Die Failure Modes	Failure Mode Distribution (%)
Channel short	30%
Channle open	30%
Enable control failure	30%
Threshold drift	10%

The FMD in Table 3-1 excludes short circuit faults across the isolation barrier. Faults for short circuit across the isolation barrier can be excluded according to ISO 61800-5-2:2016 if the following requirements are fulfilled:

1. The signal isolation component is OVC III according to IEC 61800-5-1. If a SELV/PELV power supply is used, pollution degree 2/OVC II applies. All requirements of IEC 61800-5-1:2007, 4.3.6 apply.
2. Measures are taken to ensure that an internal failure of the signal isolation component cannot result in excessive temperature of its insulating material.

Creepage and clearance requirements should be applied according to the specific equipment isolation standards of an application. Care should be taken to maintain the creepage and clearance distance of a board design to ensure that the mounting pads of the isolator on the printed-circuit board do not reduce this distance.

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4 Pin Failure Mode Analysis (Pin FMA)

This section provides a Failure Mode Analysis (FMA) for the pins of the PCA9306-Q1. The failure modes covered in this document include the typical pin-by-pin failure scenarios:

- Pin short-circuited to Ground (see Table 4-2)
- Pin open-circuited (see Table 4-3)
- Pin short-circuited to an adjacent pin (see Table 4-4)
- Pin short-circuited to supply (see Table 4-5 and Table 4-6)

Table 4-2 through Table 4-6 also indicate how these pin conditions can affect the device as per the failure effects classification in Table 4-1.

Table 4-1. TI Classification of Failure Effects

Class	Failure Effects
A	Potential device damage that affects functionality
B	No device damage, but loss of functionality
C	No device damage, but performance degradation
D	No device damage, no impact to functionality or performance

Figure 4-1 shows the PCA9306-Q1 pin diagram. For a detailed description of the device pins please refer to the *Pin Configuration and Functions* section in the PCA9306-Q1 data sheet.

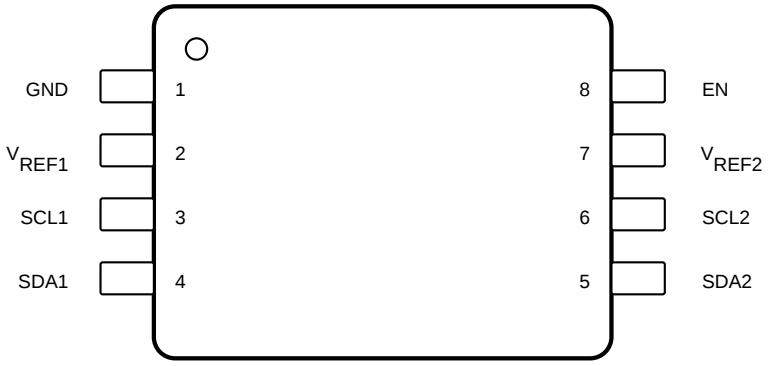

Figure 4-1. Pin Diagram

Table 4-2. Pin FMA for Device Pins Short-Circuited to Ground

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
GND	1	Normal operation, no effect.	D
VREF1	2	Communication will be corrupted and possibly cut off. Potential high current draw, and device damage if current is outside of absolute maximum ratings.	A
SCL1	3	Clock line stuck low, loss of communication.	B
SDA1	4	Data line stuck low, loss of communication.	B
SDA2	5	Data line stuck low, loss of communication.	B
SCL2	6	Clock line stuck low, loss of communication.	B
VREF2	7	No effect, normal operation if switch path signal voltages are positive. Possible damage to device if switch path signal voltages are negative. Observe that the absolute maximum ratings for all pins of the device are met, otherwise device damage may be plausible.	A
EN	8	Loss of communcation, unable to turn device on.	A

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Table 4-3. Pin FMA for Device Pins Open-Circuited

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
GND	1	Potential for data corruption. Loss of level translation functionality.	B
VREF1	2	Potential for data corruption. Loss of level translation functionality.	B
SCL1	3	Loss of communication	B
SDA1	4	Loss of communication.	B
SDA2	5	Loss of communication.	B
SCL2	6	Loss of communication.	B
VREF2	7	Potential for data corruption. Loss of level translation functionality.	B
EN	8	Potential for data corruption. Loss of level translation functionality.	B

Table 4-4. Pin FMA for Device Pins Short-Circuited to Adjacent Pin

Pin Name	Pin No.	Shorted to	Description of Potential Failure Effect(s)	Failure Effect Class
GND	1	VREF1	Communication will be corrupted and possibly cut off. Potential high current draw, and device damage if current is outside of absolute maximum ratings.	A
VREF1	2	SCL1	Clock line stuck high, loss of communication.	B
SCL1	3	SDA1	Communication will be corrupted, clock and data shorted together.	B
SDA1	4	SDA2	Not considered. This is a corner pin.	D
SDA2	5	SCL2	Communication will be corrupted, clock and data shorted together.	B
SCL2	6	VREF2	Clock line stuck high, loss of communication.	B
VREF2	7	EN	Normal operation if operated as a level translation device. Unable to disable device if operated as a switch.	B
EN	8	GND	Not considered. This is a corner pin.	D

Table 4-5. Pin FMA for Device Pins Short-Circuited to supply (VREF1)

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
GND	1	Communication will be corrupted and possibly cut off. Potential high current draw, and device damage if current is outside of absolute maximum ratings.	A
VREF1	2	Normal operation, no effect.	D
SCL1	3	Clock line stuck high, loss of communication.	B
SDA1	4	Clock line stuck high, loss of communication.	B
SDA2	5	Clock line stuck high, loss of communication.	B
SCL2	6	Clock line stuck high, loss of communication.	B
VREF2	7	Potential for data corruption. Loss of level translation functionality.	B
EN	8	Potential for data corruption. Loss of level translation functionality.	B

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Table 4-6. Pin FMA for Device Pins Short-Circuited to supply (VREF2)

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
GND	1	Communication will be corrupted and possibly cut off. Potential high current draw, and device damage if current is outside of absolute maximum ratings.	A
VREF1	2	Loss of level translation functionality.	B
SCL1	3	Clock line stuck high, loss of communication.	B
SDA1	4	Clock line stuck high, loss of communication.	B
SDA2	5	Clock line stuck high, loss of communication.	B
SCL2	6	Clock line stuck high, loss of communication.	B
VREF2	7	Normal operation, no effect.	D
EN	8	Normal operation if operated as a level translation device. Unable to disable device if operated as a switch.	B

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